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ERRATA.

On the 11th page, seventh line from the top, it reads "the moon contains one-eighth as much matter as the earth;" it should be *one-eightieth*. On the 13th page, second line under the head of Mars, "its year is thrice as long;" it should be *twice*. On page 16, near the bottom "192,080" should be 192,000.

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PREFACE.

It has been our design, in the following pages, to compile a work adapted to the wants of the rising generation. It may be successfully read by any person that has advanced in the common arithmetic as far as proportion, and by *higher* mathematical readers.

We are indebted to Hon. H. N. Robinson for his sound and unsurpassable demonstrations, found in his "University Astronomy."

The Uranography describes the whole Universe, beginning with the sun; then, advancing into the great field of space, step by step, calling upon every member of the planetary system, except the asteroids, which are too small and numerous to be interesting to our readers. It also describes the fixed stars.

The Practical Astronomy contains rules for calculating the moon's phases, eclipses, Easter, &c., &c., too tedious to mention. The Practical Astronomy must be studied as a text book; therefore, the reader need not expect to open it, and then apply the rules to the various examples; but must resort to the more elaborate method of study and inspection.

In hope that this compilation may be found useful, we submit it to the public for self-recommendation.

Union, September, 1866.

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URANOGRAPHY:

A DESCRIPTION OF THE UNIVERSE.

THE SOLAR SYSTEM.

The Solar System, as at present known, consists of the sun, its centre; eight planets revolving around it, besides about eighty-seven asteroids. According to the latest accounts, there are twenty moons revolving about these planets, unequally distributed among them; some accompanied with none at all. Such is the case with Mercury, Venus and Mars.

THE SUN.

The Sun, the great source of light and heat to the planets, is the centre of the solar system. It is an immense globe five hundred times as large as all the planets put together. Its diameter is eight hundred and eighty-three thousand miles. If the centre of the sun was placed where the centre of the earth is, it would fill the whole orbit of the moon, and reach two hundred thousand miles beyond it in all directions. Its volume is nearly a million and a half times as great as the earth's, and it contains three hundred and fifty-five thousand times as much matter.

The sun, viewed through a telescope, looks like an immense globe of fire. Its surface, however, is not always wholly luminous. A number of dark spots, surrounded by a lighter shadow, are sometimes scattered over the sun's disc, extending thirty-five degrees on each side of the solar equator. The spots on the sun seem first to have been observed in the year 1611, since which time they have constantly attracted attention, and have been the subject of investigation among astronomers. These spots change their appearance as the sun revolves on its axis, and become greater or less, to an observer on the earth, as they are turned to or from him; they also change in respect to real magnitude and number. One spot, seen by Dr. HERSCHEL, was estimated to be more than six times the diameter of our earth, being fifty thousand miles in diameter. Sometimes forty or fifty of these spots may be seen at the same time, and sometimes only one. They are often so large as to be seen with the naked eye, which was the case in 1816. In two instances these spots have been seen to burst into several parts and fly in different directions, like a piece of ice thrown upon the floor. In respect to the nature and design of these spots, almost every astronomer has formed a different theory. Some have supposed them to be solid non-luminous masses of dross, floating in the liquid fire of the sun; others, as satelites, revolving around him, and hiding his light from us; others, as immense masses, which have fallen on his disc, and are dark colored, because they have not yet become sufficiently heated. Dr. HERSCHEL, from many observations with his great telescope, concludes that the shining matter of the sun consists of a mass of phosphoric clouds, and that the spots on his disc are owing to disturbances in the equilibrium of this luminous matter, by which openings are made through it. But how can these clouds give so much heat? for the hot substance must be the luminous

substance. Therefore, we will investigate the matter after describing our earth.

We will describe the planets in their order from the sun:

MERCURY.

Mercury is the nearest planet to the sun. Mercury may be seen, at certain times of the year, for a few minutes after sunset or before sunrise, at other times it keeps so close to the sun, as to be invisible, being lost in the splendor of the solar beams, in the day time, and rising and setting so nearly with the sun, gives unfavorable opportunities for observations upon it. Viewed through a telescope, it exhibits phases, or changes, just like the moon; this is because we see more of its enlightened part at one time than another. The solar heat received at Mercury is nearly seven times as great as that of the earth—a temperature more than sufficient to make water boil. Mercury's light is also seven times as intense as ours, and the sun as seen from this planet would appear seven times as large as it does to us. Mercury's orbit deviates from a circle much more than that of any other planet, the asteroids excepted. This combined with the inclination of its axis to the orbit of the planet, produces a great variety of seasons and changes of temperature.

FIGURE 1.

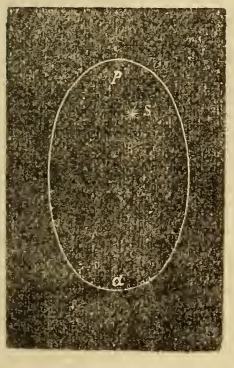


Fig. 1 *represents the orbit of a planet.* S is the sun's place nearer one end of the ellipse than the other. When the planet arrives at point P it is said to be in its perigee, and when at A its apogee.

VENUS.

The second planet from the sun is Venus. On account of its nearness it appears larger and more beautiful to us than any other member of our planetary system. This planet is so bright that it is sometimes visible at midday to the naked eye. During part of the year, this planet rises before the sun, and is then called morning star. It sets after the sun the balance of the year and is then called evening star. Venus is a little smaller than the earth. Its diameter has been calculated to be 7,587 miles. Venus' light and heat is nearly twice as great as ours. Spots have occasionally been seen on the surface of Venus, and mountains have been observed and estimated to be from fifteen to twenty miles high. Venus' phases, when viewed through a telescope, are similar to those of Mercury and the moon, but it never appears exactly full, being invisible at the time when this phase would otherwise be seen. At this time the earth, sun and Venus are in a straight line, and Venus cannot be seen for the splendor of the solar beams.

THE EARTH.

The earth is the third planet in order from the sun. The earth is round like a ball, being a little flattened at the polls. Its equatorial diameter is 7,925.5 miles, and its polar diameter about twenty-six and a half miles less. The circumference of a sphere is a little more than three times its diameter; the distance around the earth, therefore, is nearly 25,000 miles. The earth is so large that its rotundity is not apparent to a person standing on its surface. We know it to be round, however, in several ways; for every one knows the fact, that the earth has been

many times circumnavigated; which settles the question. In addition to this, any observer may convince himself of this fact; for if the observer is on shore, viewing an approaching vessel, he sees the topmast first, and from the top, downward, as the vessel gradually comes in view. This being the case on every sea, and on every portion of the earth, proves that the surface of the earth is convex on every part—hence it must be a globe, or nearly so. And furthermore, if the earth was a plain, we should see the hull as soon as the topmast. The earth makes one revolution on its axis in twenty-four hours; this is called its diurnal motion. One half of the earth's surface is constantly receiving the sun's light, and the diurnal motion of the earth keeps bringing new points into the solar beams, while at the same time withdrawing others from the sun's light. The earth has also an annual motion about the sun. Its orbit, like that of other planets, is elliptical, but does not deviate much from a circle. Its perihelion is nearly 3,000,000 miles nearer the sun than its aphelion. The earth's orbit is 600,000,000 miles in length, and to get around it in one year, the earth must travel over 68,000 miles per hour, or over 1133 miles per minute. Though we are constantly moving with this great velocity, we are unconscious of it. This is because we have never known what it is to be at rest; and again, the motion is perfectly easy and regular, there being no obstruction in the way. Perhaps we ought to have informed the reader before, that at the poles the days are six months long; when the sun is north of the equator, the north pole is illuminated, and then it is night at the south pole; and conversely, when the sun is south of the equator, it is day at the south pole, and night at the north pole.

Heat below the earth's surface—As we descend below the earth's surface, the temperature increases about one degree every forty-five feet. At this rate water would boil at a depth

of less than two miles, and at the depth of one hundred and twenty-five miles, all known substances would be melted. It is thought, therefore, that the great mass of the interior of the earth is in a state of fusion, for the heat is more than two thousand times sufficient to boil water. The discharge of lava during the eruption of volcanoes, goes to prove this; while the hot springs in different parts of the world, show that a high temperature prevails at no very great depth. At the surface, this internal heat is not perceptible, because the outer crust of the earth is a bad conductor of heat. Now if the surface of the sun is a good conductor of heat, it would allow it to pass through; and, again, if such an immense amount of heat was applied to a good conductor, such as iron, it would appear fiery like the sun; therefore, we may have reasons to believe that this is the case with the sun, and that the dark spots on its surface are asteroids falling to the sun, and when they disappear, they have become heated and are luminous; for we know no other cause to assign, unless the substance that falls on the sun's disc is entirely consumed.

It has been stated that the earth is nearer the sun, at one period of its revolution, than at another. The change of seasons, however, is entirely independent of this fact, and is produced by the sun's rays falling on a given point of the earth's surface with different degrees of obliquity at different parts of its orbit. When the sun is vertical or directly overhead, its heat is most intense, and the less its rays deviate from a vertical line, in striking the surface, the more heat they impart to it. The angle at which the sun's rays strike a given part of the earth's surface keeps constantly varying in consequence of the earth's revolution in her orbit, with its axis always pointing in one direction, or, as it is generally expressed, always parallel to itself.

THE MOON.

The earth is attended by one satellite called the moon—a beautiful orb which rules the night with its gentle brilliancy,—commander-in-chief of the waters, and sensibly affects the earth's motion. The moon's diameter is 2,165 miles, but its apparent size is nearly equal to that of the sun's on account of its nearness to our planet. Its density is but little more than one-half that of the earth, and it contains about one-eighth as much matter. The moon's mean distance is 240,000 miles from the earth, and makes one revolution in its orbit in about twenty-seven days and eight hours. From new moon to new moon it requires about twenty-nine days and thirteen hours on account of the sun's apparent motion from the moon. When any planet or satellite is nearest to the body it revolves around, it is said to be in perigee, and when farthest, in apogee. We have just used the term—sun's apparent motion—because the sun does really appear to move, instead of the earth. But this is not so; the earth revolves around the sun, as it has been previously stated. The moon revolves on its axis in exactly the same time it takes it to revolve round the earth, and in the same direction. This is the most wonderful observed fact that has ever been seen in our infinite extended universe. This coincidence seems almost impossible according to the laws of astronomy as discovered by KEPLER, which will hereafter be investigated for the reader to crack his skull on, and to solve some very nice astronomical problems. The moon is non-luminous and shines only by the reflected light of the sun; hence, the half sphere presented to the sun is bright, while the opposite one is dark. The sun, moon and earth are constantly taking different positions in respect to each other, and the illuminated portion is changing also.

Hence, arises, what are called the moon's phases. When new, the moon lies between the earth and sun, near a line connecting their centres. Her dark side is then toward us and she is invisible, but very soon we see her in the west, a little after sunset, with a beautiful crescent on the side next to the sun. Every night we find the crescent still growing larger and larger, and, finally, she is seen ninety degrees west of the sun ; half her disc is then illuminated. She is then said to be in her first quarter, but her crescent or illuminated part, still increases, until she arrives at a point where the earth, sun and moon are again in a straight line or nearly so ; but this time the earth is in the middle, therefore, we are on the same side of the moon as the sun is, and the enlightened side being always next to the sun, it is visible to us, and is called full moon. When she advances ninety degrees beyond full she reaches her third quarter. Then she presents the same amount of luminated surface as she did in the first quarter, but this time the east side of the moon is visible. She advances still farther, until she finally presents her dark side to us again ; after this she will go through the same phases, as she makes another revolution in her orbit. As seen from the moon, the earth presents the same phases that the moon does to us, but in reverse order. When we have new moon, the moon has full earth—a splendid orb, thirteen times as large as the full moon. When she is in her first quarter, the earth is in her third quarter, &c. Most of the writers say that the moon has no atmosphere ; hence, it must be destitute of water, for any liquid on its surface would long since have been evaporated by the heat of the lunar days. Viewed through a telescope, the surface appears very rough, covered with deep valleys and lofty mountains, several of which are from three to four miles high, and their shadows have been seen to extend across the rugged plains. Several of the ancient astronomers thought they could discover vol-

canoes in a state of eruption, with their great telescopes; but the latest accounts say that the supposed volcanoes are superior reflective substances. The great telescope of the EARL OF ROSSE shows plainly every object on the lunar surface that is one hundred feet high, but shows no signs of life or habitation.

MARS.

Mars, the fourth planet from the sun, is 4,546 miles in diameter. Its day is a little longer than ours, and its year about thrice as long. About every other year, when it comes to the meridian, near midnight, it is then most conspicuous, and the next year it is scarcely noticed by the common observer. This may seem rather strange to the reader, but we will see if we cannot simplify it. The distance from the sun to Mars is about one hundred and forty-four millions of miles and the earth being about ninety-five millions of miles from the sun; when Mars is on the same side of the sun that the earth is, the distance from us to Mars equals 144,000,000—95,000,000=49,000,000; hence, our distance from Mars at this time is only forty-nine millions of miles. One more year finds our earth in the same position, and, as it takes Mars two years to make a revolution, by this time she has only made half a revolution. Therefore, Mars is on the opposite side of the sun from the earth, and her distance from the earth is equal to $144,000,000 + 95,000,000 = 239,000,000$, which is nearly five times her distance one year previous, and it is evident that she would appear smaller. The apparent sizes of the other planets do not change like that of Mars because their relative change in distance is not so great. (Venus is an exception to this, her farthest distance is about six times her less.) The physical appearance of Mars is somewhat remarkable. His

polar regions, when seen through a telescope, have a brilliancy so much greater than the rest of his disc, that there can be little doubt, that, as with the earth, so with this planet, accumulations of ice or snow take place during the winters of those regions. In 1781, the south polar spot was extremely bright; for a year it had not been exposed to the solar heat. The color of the planet most probably arises from a dense atmosphere which surrounds him, of the existence of which there is other proof, depending on the appearance of stars as they approach him; they grow dim and are sometimes wholly extinguished as their rays pass through that medium. Mars is easily distinguished in the heavens by his red, fiery appearance.

JUPITER.

The next planet, as known to ancient astronomers, is Jupiter; but its distance is so great beyond the orbit of Mars, that the vast field of space between the two was considered as an imperfection, and it was thought among astronomers that a planet ought to occupy that vacant space. The discovery of Bodi's law encouraged the belief among the astronomers that there was once a planet between Mars and Jupiter. It is as follows, if we take the series of numbers as below:

0, 3, 6, 12, 24, 48, 96, 192, &c., and then add the number 4 to each, and we have 4, 7, 10, 16, 28, 52, 100, 196, &c., &c. This last series of numbers very nearly corresponds to the relative distances of the planets from the sun, with the exception of the number 28. It was this trivial number 28 that introduced the subject of investigating the theory of explosion, combined with the many asteroids afterwards discovered in this vacant field of space, of which the 87th has been lately discovered by Prof.

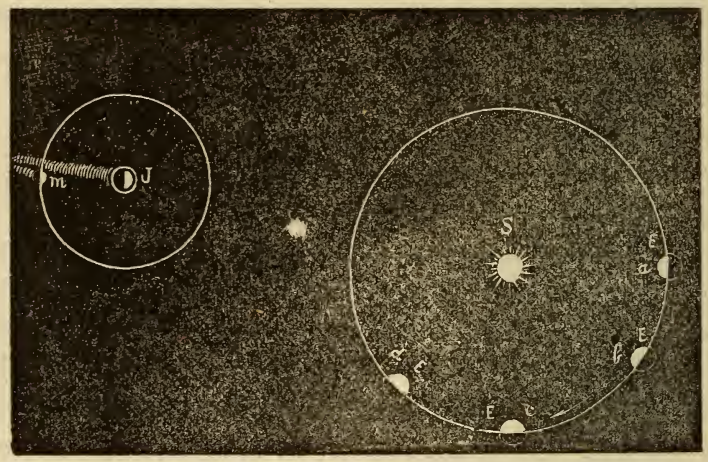
N. R. POGSON, of the Royal Observatory, Madras. Hence, it was the general impression among astronomers, that there was once a planet revolving around the sun in this field of space, and from some cause or other it exploded, sending fragments in many directions. It does seem strange that there are so many small worlds, and their orbits so near together, were they not formerly one body. Now, if these little worlds were scattered from Mercury to Neptune, no such thought would have penetrated the minds of the astronomers.

Jupiter is the largest planet in the solar system, being nearly one thousand three hundred times as large as our earth. Its revolution around the earth is performed in about twelve years, and it only takes this great globe ten hours to make one revolution around its axis. It revolves with such great velocity that every point on its equator must turn four hundred and fifty miles per minute. So great is the centrifugal force at the equator that its poles are flattened very much. The disc of Jupiter is always crossed, in an eastern and western direction, by dark bands. These belts are not alike at all times; they vary in breadth and in situation, but never in their direction. They have even been seen broken up and distributed over the whole face of the planet, but this vision is extremely rare. When Jupiter is viewed with a telescope, even of moderate power, it is seen accompanied by four small stars, nearly in a straight line parallel to the ecliptic. These always accompany the planet, and are called its satellites or moons. They are always changing their position with respect to one another and to the planet, being sometimes all to the left, and somtimes all to the right; but generally some on each side. These moons are not all the same distance from the planet, and they are thus distinguished: that being called the first, which is nearest to the planet; the next nearest is called the second, and so on. GALILEO discovered the

the satellites of Jupiter in 1610. Sometimes a satellite passes between the sun and Jupiter, and casts a shadow which describes a chord across the disc of the planet. This produces an eclipse of the sun, to Jupiter similar to those which the moon produces on the earth, which shows that Jupiter and his moons are non-luminous bodies, shining by the reflected light of the sun. The motions of Jupiter's moons are from west to east, just the same way as the earth's moon.

The velocity of light was discovered by the eclipses of Jupiter's satellites, which we illustrate thus:

FIGURE 2.



Let S (Fig. 2) represent the sun, J Jupiter, E earth and M Jupiter's first satellite. Now this satellite passes through Jupiter's shadow every revolution it makes around the planet. Suppose the earth is at the point A when M is seen entering Jupiter's shadow. Now E is moving in the direction indicated by the arrow, which, as it is shown, is at right angles towards Jupiter. In 42h, 28m and 35s, M is again seen entering the shadow; by this time E has arrived at the point B, about the same distance from J, as the earth when it was at point A, as is seen by the figure. Therefore, it is 42h, 28m and 35s from one eclipse to another. Now if we renew the observation: When E is moving from C to D, toward J, the time between the eclipses will be shortened fifteen seconds, on account of the earth advancing on meeting the light; and during this time the earth has moved in its orbit 2,880,000 miles; this divided by fifteen, will give 192,080 miles for the velocity of light per second.

All of Jupiter's satellites are larger than our moon, except one, and three of them are eclipsed every lunation, yea, totally eclipsed; and the fourth is very often eclipsed. The relation between the orbits and motions are such that for many years to come, Jupiter will never be deprived of the light of all her moons at the same time.

SATURN.

The next planet in order of remoteness from the sun, is Saturn, the most wonderful object in the solar system. This world, though less than Jupiter, is about 79,800 miles in diameter, and one thousand times greater than our earth. This great globe is attended by eight satellites or moons, and is surrounded by two broad, flat and extremely thin rings; both lying in one plane, and separated by a very narrow space, and from the planet by a much wider.

The dimensions are as follows:

	Miles.
Exterior diameter of exterior rings	176,418
Interior do do	155,272
Exterior diameter of interior ring	151,690
Interior do do	117,339
Equatorial diameter of the planet	79,160
Interval between the planet and interior ring	19,090
Interval of the rings	1,791
Thickness of the rings	100

The body of Saturn is striped, similar to that of Jupiter, and the planet and rings are known to be opaque, by the shadows they cast upon each other; which may be seen by the aid of a telescope. The diameter of Saturn's largest moon is about 3,247 miles. The rings reflect light to the planet, and are a very good substitute for a moon; these rings are said to be solid masses revolving with great rapidity around the planet, therefore, the

centrifugal force balances the attraction of the planet, and keeps them from falling in on the disc of the body. These rings revolve around the planet in the surprisingly short period of ten hours, twenty-nine minutes and seventeen seconds; hence, every point on the exterior circumference of the exterior ring, must turn eight hundred and eighty miles per minute. Saturn's day is not half so long as ours, but it is twenty-nine and half of our years in making one complete revolution in its orbit.

URANUS.

The next planet beyond Saturn is Uranus. It was discovered by Sir W. F. HERSCHEL in the year 1781. Uranus is rarely to be seen, without a telescope; yet, under faxorable circumstances, it may be, as a star of the sixth magnitude.* Its real diameter is about 35,000 miles, or, about eighty times the size of our earth; and it takes it eighty-four years to make one revolution around the sun. Uranus is attended by six moons, which move from East to West, contrary to the motions of other moons, and nearly perpendicular to the orbit of the planet. Uranus is eighty times the magnitude of the earth.

NEPTUNE.

Neptune, the most remote planet of the solar system, is invisible to the naked eye. We have no account of the surface of the planet, but its diameter is 39,800 miles, which is about one hundred and twenty-five times as large as our earth. Neptune performs its revolution around the sun in about one hundred and

*The visible stars are divided into six classes. The brighter are of the first magnitude, and those just visible are of the sixth.

sixty-five years. It has one moon which is about 250,000 miles from the planet. Neptune was discovered in the year 1846 by two astronomers, both of Europe. However strange, both astronomers told the distance from the sun, the size and time of revolution of the planet Neptune around the sun without ever seeing it; and even went so far as to assign its position in the heavens, at a given date. As the historian says, it was on the 13th of September, that the results of these calculations reached Dr. GALLE, of Berlin, and that very evening he searched the predicted point with his large telescope. The inquiry was, is it there? Yes, it is there. These calculations were made by comparing observations on the perturbations of Uranus. We will give practical exercises on this in the Practical Astronomy which will explain the proposition.

We will now give the reader a comparative representation of the solar system:

"Choose any well leveled field or bowling green. On it place a globe two feet in diameter; this will represent the sun; Mercury will be represented by a grain of mustard seed, on the circumference of a circle of 164 feet in diameter, for its orbit. Venus a pea, on a circle 284 feet in diameter; the earth also, a pea, on a circle of 430 feet; Mars a rather large sized pinhead, on a circle of 654 feet; Juno, Ceres, &c., &c., grains of sand, in orbits of from 800 to 1500 feet; Jupiter a moderate sized orange, in a circle nearly half a mile across, Saturn a small orange, on a circle of four-fifths of a mile; and Uranus a full sized cherry, or small plum, upon the circumference of a circle more than a mile and a half in diameter. As to getting correct notions on this subject by drawing circles on paper, or, still worse, from those very childish toys called orreries, it is out of the question. To imitate the motions of the planets in the above mentioned orbits, Mercury must describe its own diameter in 41 seconds; Venus,

in 4 minutes and 14 seconds; the earth, in 7 minutes; Mars, in 4 minutes, 48 seconds; Jupiter, in 2 hours, 56 minutes; Saturn, in 3 hours, 13 minutes; and Uranus, in 2 hours, 16 minutes.—*Herschel's Astronomy.*

COMETS.

Besides the planets, satellites and asteroids, there are great numbers of other bodies, which gradually appear, increasing in brightness and velocity, until they reach their perihelion, and as gradually diminish, pass off and are lost in the distance; these are called comets. From their physical appearance, especially of their long luminous tails, they were for a long time objects of terror to mankind, and were regarded with superstitious terror as precursors of war, famine and other pestilences. It has only been about sixty years since these fears were banished by a knowledge of the rarity of comets; and being now better understood, excite only the curiosity of the people in general. Hon. H. N. Robinson says: It is further to be observed that the tails of comets begin to appear, as the bodies approach the sun; their length increases with this proximity, and they do not acquire their greatest extent, until after passing the perihelion. The direction is generally opposite to the sun, forming a curve slightly concave, the sun on the concave side. The portion of the comet nearest to the sun, must move more rapidly than its remoter parts, and this will account for the lengthening of the tail. The tail is, however, by no means an invariable appendage of comets. Many of the brightest have been observed to have short and feeble tails, and not a few have been entire without them. On the other hand, instances are not wanting of comets furnished with many tails, or streams of diverging light. That of 1744 had no less than six, spread out like an immense fan, extending to a

distance of nearly thirty degrees in length. The smaller comets, such as are visible only in telescopes, and far the most numerous, offer frequently no appearance of a tail, and appear only as round or somewhat oval vaporous masses, more dense toward the center; where, however, they appear to have no distinct nucleus, or anything which seems entitled to be considered as a solid body. The tail of the comet of 1456, was sixty degrees long. That of 1618, one hundred degrees, so that its tail had not all risen when its head reached the middle of the heavens. The comet of 1680 was so great, that though its head set soon after the sun, its tail, seventy degrees long, continued visible all night. The comet of 1689, had a tail sixty-eight degrees long. That of 1769, had a tail more than ninety degrees in length. That of 1811, had a tail twenty-three degrees long. The recent comet of 1843, had a tail sixty degrees in length.

Comets, in passing among and near the planets, are materially drawn aside from their courses, and in some cases have their orbits entirely changed. This is remarkably the case with Jupiter, which seems, by some strange fatality, to be constantly in their way, and to serve as a perpetual stumbling block to them. In the case of the remarkable comet of 1770, which was found by LEXELL to revolve in a moderate ellipse in the period of about five years, and whose return was predicted by him accordingly—the prediction was disappointed by the comet actually getting entangled among the satellites of Jupiter, and being completely thrown out of its orbit by the attraction of that planet, and forced into a much larger ellipse. By this extraordinary rencounter, the motion of the satellites suffered not the least perceptible derangement, which is a sufficient proof of the smallness of the comet's mass.—*Robinson's Astronomy.*

The following are part of the elements of the orbits of the three comets, which have appeared according to prediction, taken from the work of Professor LITTROW.

	Halley.	Encke,	Biela.
Major axis of orbit, that of the earth being called 1,	18.	2.2	3.6
Minor axis.	4.6	1.2	2.4
Time of revolution, in years,	76.	3.29	6.74
Time of the perihelion passage,	Nov. 16, 1835.	May 6, 1832.	Nov. 27, 1832

About one hundred and twenty comets have been foretold, but this is nothing compared with the whole number, that visit our solar system, which is estimated by some to be about 7,000,000, and by others to be about 28,000,000. But we can say that we are ignorant of the number, for all such calculations must surely be guess work. It is said that in 1454, the moon was eclipsed by a comet. This undoubtedly was very alarming, for the comet was less than 240,000 miles from the earth, and its rarity was not understood at this time. Professor Kendall, in his Uranography, speaking of the fears occasioned by comets, says: "Another source of apprehension, with regard to comets, arises from the possibility of their striking our earth. It is quite probable that even in the historical period the earth has been enveloped in the tail of a comet. It is not likely that the effect would be sensible at the time. The actual shock of the head of a comet against the earth is extremely improbable. It is not likely to happen once in a million of years.

If such a shock should occur, the consequences might perhaps be very trivial. It is quite possible that many of the comets are not heavier than a single mountain on the surface of the earth. It is well known that the size of mountains on the earth is illustrated by comparing them to particles of dust in a common globe.

FIXED STARS.

The fixed stars are so called, because they maintain the same position relatively to each other. For example, you see the

seven stars forming the same dipper they did years ago. The number of fixed stars is unknown. The telescope reveals millions ; however, great the magnifying power, it brings stars into the field of view that are just discernible. The fixed stars are divided into twenty magnitudes, according to their brightness ; the first six are visible to the naked eye ; the rest are called telescopic stars, because seen only with the telescope. There are about twenty-four stars of the first magnitude, fifty of the second and two hundred of the third ; but the number in the other classes increases so rapidly as to be beyond enumeration. The fixed stars are suns, occupying the centre of a system, probably, similar to ours. They are supposed to be of different sizes, and situated at different distances from the sun. The distance to the fixed stars is so great that if the sun filled the whole orbit of the earth it would be invisible from them. It is said that the recent improvements in telescopes have enabled astronomers to compute the distance of nine of the nearest stars. It is shown in the preceding pages that light flies 192,000 miles in one second, but it would take it fourteen years to fly from the star Sirus to us, and from the Pole star it would take forty-eight years ; and it is conjectured that the magnifying power of the great telescopes will penetrate 363,294,720,000,000,000 miles into the field of space, a distance that light could not traverse in less than sixty thousand years.* The mind is lost in comprehending such a mighty distance. The Milky Way, is a broad belt of apparent vaporous light, extending from the pole in the north to the horizon in the south. The stars are so thick in this zone of light that their rays are blended together, which is the cause of it appearing like a cloud of vapor.

Dr. HERSCHEL saw, in the course of a quarter of an hour, the

*If all the stars would explode at this time, some of them would be seen in their present position for more than sixty thousand years.

astonishing number of 116,000 stars pass through the field of view, when he directed his powerful telescope to this almost endless zone of light. Although they appear so thick, they must be at least 9,500,000,000,000 miles apart, which is 100,000 times the radius of the earth's orbit; and it is calculated that their diameters cannot fall short of 200,000,000 miles.

MEASURING THE DISTANCE TO THE SUN.

We shall now give the reader an idea how the distance to the sun is told. If a globe, say ten feet in diameter, be placed just before your eyes, it will obscure all of the sight, but as it is rolled away from you, its apparent size grows smaller and smaller as the distance increases. Hence, to every apparent size there is a corresponding distance, and if we know the increase in distance corresponding to the decrease in the apparent size, we may assign its position at any time; but this is a geometrical problem, and will have to be omitted in a work like this. Upon this principle all distances are told without measuring.

ARE THE CELESTIAL WORLDS INHABITED?

We close the Uranography by asking a question that has never

been answered. Are the celestial worlds inhabited? We ask this question, but cannot answer it; nor will it be answered until there is a great improvement made in telescopes. All that we can say upon this subject, is, that we believe all of the planets are inhabited. We know that one is — the earth — and from the similar appearance of the other planets, it is natural to suppose that they are also inhabited. Nothing seems to be created without an object, and it would appear very strange if the earth were the only one peopled by intelligent creatures. If we inhabited Jupiter, our weight might overcome our strength and make us helpless; but who can doubt that the Great Creator, who has adopted us to our globe, could as easily adopt creatures to others.

PRACTICAL ASTRONOMY.

REMARKS.

The following astronomical calculations are approximate, but sufficiently accurate to meet the wants of the reader. The results of the calculations of the moon's phases, eclipses, &c., are within five or six minutes of the true time, and often much nearer. The time of the moon's entrance into its apogee and perigee, may be predicted to the nearest hour; and we believe that the rest of the calculations are very accurate.

PRACTICAL ASTRONOMY.

MOON'S PHASES.

The phases of the moon have been explained in the Uranography; and we shall now attempt to calculate them by the following tables, hoping that the reader will readily understand us; although, we will not explain how these tables were made, because it would take a mathematician to understand it. All tabular calculations are made from Greenwich mean time.

To Find the New Moons in any Given Year.— From table I. take out the given year and the whole horizontal line headed as above. The second column shows the mean time of the first new moon in the year, reckoned from the beginning of the same year. The columns headed I., II., III. and IV., correct the mean, and give the apparent time of new moon. If we want the second new moon we must add one lunation and the whole horizontal line taken from table II.; the heading of which corresponds to the first. If the third new moon is required, we must add two lunations. (The first column in table II., shows the number of lunations.) And when this is done, add up each column separately. But if there are more than four figures under columns I. or II., drop the last figure in adding; and if more than two under columns III. or IV.,

also drop the last figure in adding. And then with sum under column I. enter table III., and with its nearest equivalent, found in a column headed Arg.; take out the corresponding equation from column I., and place it in the column of days, hours and minutes. Then proceed in the same manner with the numbers under columns II., III. and IV., and again add up the column of days, hours and minutes, which will be the apparent Greenwich time, reckoned from the beginning of the year. Now subtract from the number of days, the greatest number that can be subtracted, taken from table IV., if it is a common year, take the number to be substracted from column headed Com., otherwise from column headed Leap. The remainder will be the day of the the corresponding month.

TABLE I.

MEAN NEW MOONS AND ARGUMENTS IN JANUARY.

	MEAN N. MOON IN JAN.			I.	II.	III.	IV.	N.
A. D.	D.	H.	M.					
1861	10	9	22	0290	2840	31	25	995
1862	29	6	55	0800	2163	30	14	102
1863	18	15	44	0504	0769	13	03	125
1864 L	8	0	32	0204	9374	96	92	147
1865	25	22	5	0714	8698	94	80	256
1866	15	6	53	0416	7303	77	69	277
1867	4	15	42	0118	5909	60	58	299
1868 L	23	13	14	0628	5231	59	46	407
1869	11	22	3	0330	3837	42	35	429
1870	1	6	51	0032	2442	25	24	451
1871	20	4	24	0542	1765	23	12	559
1872 L	8	13	13	0244	0371	05	01	581
1873	27	10	46	0754	9694	03	89	689
1874	17	19	35	0456	8300	86	78	711
1875	7	4	24	0158	6906	69	67	733
1876 L	26	1	57	0668	6229	67	55	841
1877	14	10	49	0370	4835	50	44	863
1878	3	18	38	0072	3441	33	23	885
1879	22	6	11	0582	2764	31	21	993
1880 L	11	15	0	0280	1370	14	10	015
1881								
1882								

☞ The letter L is affixed to the Leap years in the first column.

TABLE II.

MEAN LUNATIONS AND CHANGES OF ARGUMENTS.

NO.	LUNATION.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1–128	0	05	32	0006	0084	01	01	001
1–64	0	11	4	0012	0167	02	02	001
1–32	0	22	9	0025	0335	04	03	003
1–16	1	20	18	0050	0670	07	06	005
1–12	2	11	4	0068	0893	09	08	007
1–8	3	16	35	0101	1339	14	12	011
1–6	4	22	7	0135	1786	19	17	014
1–4	7	9	11	0202	2679	29	25	022
1–2	14	18	22	0404	5359	58	50	043
1	29	12	44	0808	0717	15	99	085
2	59	1	28	1617	1434	31	98	170
3	88	14	12	2425	2151	46	97	256
4	118	2	56	3234	2869	61	96	341
5	147	15	40	4042	3586	76	95	425
6	177	4	24	4851	4303	92	95	511
7	206	17	8	5659	5020	07	94	596
8	236	5	52	6468	5737	22	93	682
9	265	18	36	7276	6454	37	92	767
10	295	7	20	8085	7171	53	91	852
11	324	20	5	8893	7889	68	90	937
12	354	8	49	9702	8606	83	89	022
13	383	21	33	0510	9323	98	88	108

TABLE III.

EQUATIONS FOR ARGUMENTS I. AND II.

ARG.	I.		II.		ARG.	I.		II.	
	H.	M.	H.	M.		H.	M.	H.	M.
0000	4	20	10	10	5000	4	20	10	10
0100	4	36	9	36	5100	4	05	10	50
0200	4	52	9	2	5200	3	49	11	30
0300	5	8	8	28	5300	3	34	12	9
0400	5	24	7	55	5400	3	19	12	48
0500	5	40	7	22	5500	3	4	13	26
0600	5	55	6	49	5600	2	49	14	3
0700	6	10	6	17	5700	2	35	14	39
0800	6	24	5	46	5800	2	21	15	13
0900	6	38	5	15	5900	2	8	15	46
1000	6	51	4	46	6000	1	55	16	18
1100	7	4	4	17	6100	1	42	16	48
1200	7	15	3	50	6200	1	31	17	16
1300	7	27	3	24	6300	1	19	17	42
1400	7	37	2	59	6400	1	9	18	6
1500	7	47	2	35	6500	0	59	18	28
1600	7	55	2	14	6600	0	50	18	48
1700	8	03	1	53	6700	0	42	19	6
1800	8	10	1	35	6800	0	34	19	21
1900	8	16	1	18	6900	0	28	19	33
2000	8	21	1	03	7000	0	22	19	44
2100	8	25	0	51	7100	0	17	19	52
2200	8	29	0	40	7200	0	14	19	57
2300	8	31	0	32	7300	0	11	20	0
2400	8	32	0	25	7400	0	9	20	1
2500	8	32	0	21	7500	0	8	19	59
2600	8	31	0	19	7600	0	8	19	55
2700	8	29	0	20	7700	0	9	19	48
2800	8	26	0	23	7800	0	11	19	40
2900	8	23	0	28	7900	0	15	19	29
3000	8	18	0	36	8000	0	19	19	17
3100	8	12	0	47	8100	0	24	19	2
3200	8	6	0	59	8200	0	30	18	45
3300	7	58	1	14	8300	0	37	18	27
3400	7	50	1	32	8400	0	45	18	6
3500	7	41	1	52	8500	0	53	17	45
3600	7	31	2	14	8600	1	3	17	21
3700	7	21	2	38	8700	1	13	16	56
3800	7	9	3	04	8800	1	25	16	30
3900	6	58	3	32	8900	1	36	16	3
4000	6	45	4	2	9000	1	49	15	34
4100	6	32	4	34	9100	2	2	15	5
4200	6	19	5	7	9200	2	16	14	34
4300	6	5	5	41	9300	2	30	14	3
4400	5	51	6	17	9400	2	45	13	31
4500	5	36	6	54	9500	3	0	12	58
4600	5	21	7	32	9600	3	16	12	25
4700	5	6	8	11	9700	3	32	11	52
4800	4	51	8	50	9800	3	48	11	18
4900	4	35	9	30	9900	4	4	10	44

TABLE III.— *Continued.*

EQUATIONS FOR ARGUMENTS III. AND IV.

ARG.	III.	IV.	ARG.	III.	IV.	ARG.	III.	IV.	ARG.	III.	IV.
	M.	M.		M.	M.		M.	M.		M.	M.
00	10	20	25	3	31	50	10	20	75	17	9
01	10	21	26	3	31	51	10	19	76	17	9
02	9	21	27	3	30	52	11	19	77	17	10
03	9	22	28	3	30	53	11	18	78	17	10
04	8	23	29	3	30	54	12	17	79	17	10
05	8	23	30	3	30	55	12	17	80	17	10
06	7	24	31	3	30	56	13	16	81	17	10
07	7	25	32	4	29	57	13	15	82	16	10
08	7	25	33	4	29	58	13	15	83	16	11
09	6	26	34	4	29	59	14	14	84	16	11
10	6	26	35	4	29	60	14	14	85	16	11
11	5	27	36	5	28	61	15	13	86	15	12
12	5	27	37	5	28	62	15	13	87	15	12
13	5	28	38	5	27	63	15	12	88	15	13
14	5	28	39	5	27	64	15	12	89	15	13
15	4	29	40	6	26	65	16	11	90	14	14
16	4	29	41	6	26	66	16	11	91	14	14
17	4	29	42	7	25	67	16	11	92	13	15
18	4	29	43	7	25	68	16	10	93	13	15
19	3	30	44	7	24	69	17	10	94	13	16
20	3	30	45	8	23	70	17	10	95	12	17
21	3	30	46	8	23	71	17	10	96	12	17
22	3	30	47	9	22	72	17	10	97	11	18
23	3	30	48	9	21	73	17	10	98	11	19
24	3	31	49	10	21	74	17	9	99	10	19

TABLE IV.

NUMBER OF DAYS FROM THE COMMENCEMENT OF THE YEAR TO THE FIRST OF EACH MONTH.

MONTHS.	COM.	LEAP.	MONTHS.	COM.	LEAP.
January.....	0	0	July.....	181	182
February.....	31	31	August.....	212	213
March.....	59	60	September.....	243	244
April.....	90	91	October.....	273	274
May.....	120	121	November.....	304	305
June.....	151	152	December.....	334	335

EXAMPLES.

1. Required the time of new moon in January, 1866, Greenwich apparent time.

Bring down the whole horizontal line corresponding to the year 1866, found in table I.:

	MEAN NEW MOON			I.	II.	III.	IV.	N.
	D.	H.	M.					
1866	15	6	53	0416	7303	77	69	277
	15	6	53	0416	7303	77	69	277
I.		5	27					
II.		20	00					
III.			17					
IV.			10					
January	16	08	47					

Now with the number, 0416, enter column Arg., in Table III; and take from its corresponding column I. the hours and minutes corresponding to the number; but its nearest equivalent is 0400, and the equation 5 hours and 24 minutes. Now, while the number is increasing from 0400 to 0500, the equation increases from 5 hours and 24 minutes to 5 hours and 40 minutes; and, by proportion, we find that while the argument is increasing from 0400 to 0416, the equation increases 2.56 minntes, which, added to 5 hours, 24 minutes, gives 5 hours, 26.56 minutes for the equation corresponding to the number 0416; but the equations are always added to the time column to their nearest minute; therefore, we will add 5 hours and 27 minutes. We may proceed in the same manner with the arguments, 7303, 77 and 69, always taking the equations from columns headed the same as their arguments. After the equations are all added to the time of mean new moon, we have, new moon, January, 16 days, 8 hours and 47 minutes, Greenwich apparent time. As Greenwich is east of the United States, it is later in the day there than in this country. And if we substract the difference of time between Greenwich and any point in the United States, we will have the time corresponding to that point. For this purpose we inser

Table V. For instance, if we want the time of new moon at Washington, D. C., all we have to do is, to subtract the difference of time as shown by Table V., which is 5 hours and 8 minutes, subtracted from Greenwich time of new moon, leaves 16 days, 3 hours and 39 minutes, for Washington time of new moon.

TABLE V.

SHOWING THE DIFFERENCE OF TIME BETWEEN GREENWICH AND CITIES, ETC., IN THE UNITED STATES AND CANADAS.

TOWNS.	Difference of Time.		TOWNS.	Difference of Time.	
	H.	M.		H.	M.
Augusta, Maine	4	40	Galveston, Texas	6	20
Portland, "	4	41	Austin, "	6	31
Concord, New Hampshire	4	46	Cleveland, Ohio	5	27
Montpelier, Vermont	4	50	Cincinnati, "	5	38
Boston, Massachusetts	4	44	Columbus, "	5	32
Northampton, Mass	4	50	Frankfort, Kentucky	5	39
Newport, Rhode Island	4	45	Mammoth Cave, Ky	5	43
Hartford, Connecticut	4	50	Bowling Green, Ky	5	45
New York, N. Y.	4	56	Shelbyville, Indiana	5	42
Syracuse, New York	5	5	Indianapolis, "	5	44
Buffalo, " "	5	16	Terre Haute, "	5	50
Trenton, New Jersey	4	59	Chicago, Illinois	5	51
Philadelphia, Penna.	5	1	Peoria, "	5	58
Harrisburg, "	5	7	Rock Island,"	6	2
Pittsburg, "	5	20	Alton, "	6	1
Dover, Delaware	5	2	Quincy, "	6	6
Baltimore, Maryland	5	6	St. Louis, Missouri	6	1
Washington, D. C.	5	8	Pilot Knob, "	6	3
Richmond, Virginia	5	10	Palmyra, "	6	6
Natural Bridge, Va	5	18	JeffersonCity "	6	9
Washington, N. C.	5	8	St. Joseph, "	6	20
Raleigh, N. C.	5	14	Davenport, Iowa	6	2
Salisbury, N. C.	5	22	Keokuk, "	6	6
Charleston, S. C.	5	20	Des Moines, "	6	15
Columbia, S. C.	5	24	Madison, Wisconsin,	5	57
Savannah, Georgia	5	25	Milwaukee "	5	52
Columbus, "	5	40	Pictured Rocks, Mich	5	44
Suwanee River, Florida	5	33	Detroit, "	5	32
Milton, "	5	49	San Diego, California	7	49
Montgomery, Alabama	5	46	San Francisco, Cal	8	10
Mobile, "	5	53	Monterey, Mexico	8	8
Jackson, Mississippi	6	01	Quebec, Canada	4	45
Natchez, "	6	6	Stanstead, "	4	49
Nashville, Tennessee	5	47	St. Johns, "	4	53
Memphis, "	6	1	Montreal, "	4	54
Little Rock, Ark.	6	10	Toronto, "	5	17
New Orleans, Louisiana	6	0	Paris, "	5	21
Shrevesport, "	6	16			

NOTE. — Time, as calculated by the Tables, is astronomical time, and is counted from noon till noon, and from one to twenty-four hours. Therefore, the astronomical day commences at the middle of the civil day, and is by this cause twelve hours behind it. Then, if we add 12h. to the astronomical day it will reduce it to a civil one, reckoned from midnight to midnight, and from one to twenty-fours. From 1 to 12 corresponds to A. M., and from 12 to 24 to P. M.

2. Required the time of the third new moon in 1866, corresponding to Greenwich, Boston, and Cincinnati astronomical and civil time.

	MEAN NEW MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1866	15	6	53	0416	7303	77	69	277
2 Lun.	59	1	28	1617	1434	31	98	170
	74	8	21	2033	8737	08	67	447
I.		8	22					
II.		16	49					
III.			7					
IV.			11					
	75	9	50					
Table IV.	59							
March	16	9	50					

New moon, Greenwich Astronomical time, March.....16d. 9h. 50m.
Boston difference of time (Table V.)..... 4 44

New moon, Boston astronomical time 16 5 06
In the same manner, we find new moon, Cincinnati, astronomical time.....16 4 12

Following instructions in the preceding note we have :

Greenwich civil time.....16d. 9h. 50m. P. M.
Boston, " " .....16 5 06 "
Cincinnati " " .....16 4 12 "

☞ After this, astronomical time will be meant, when other time is not mentioned.

3. Required the sixth new moon, in 1868, civil time, for Washington, D. C.

	MEAN NEW MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1868 L.	23	13	14	0628	5231	59	46	407
5 Luna.	147	15	40	4042	3586	76	95	425
	171	4	54	4670	8817	35	41	832
I.		5	11					
II.		16	25					
III.			4					
IV.			26					
	172	3	00					
Table IV. L.	152							
June	20	3	00					

Greenwich time, June.....20d. 3h. 00m.
Washington difference of time..... 5 8

Washington time.....20d. 21h. 52m

Adding 12 hours, we have Washington civil time, 21d. 8h. 52m. A. M,

EQUATION OF TIME.

THE SUN gives apparent time, and there must be another correction applied to give the true time as shown by a perfect clock. It is called the equation of time, and is from two causes.

1*st. The unequal apparent motion of the Sun along the Ecliptic.*

2*d. The variable inclination of this motion to the Equator.*

The true time corresponds with apparent time, four days in every year; or in other words, the four days in the year on which the sun and clock agree, are April 15th, June 16th, September 1st, and December 24th. Table VI. shows the equation of time

for every fifth day of the year. The equations to be added to apparent time, are placed in column headed Add, and *vice versa*.

TABLE VI.

SHOWING THE EQUATION OF TIME FOR EVERY FIFTH DAY IN THE YEAR.

Day of Month.	Add.	Sub-tract.	Day of Month.	Add.	Sub-tract.	Day of Month.	Add.	Sub-tract.
	M.	M.		M.	M.		M.	M.
Jan..... 5	6		*May*... 5		3	*Sept*... 2		1
" 10	8		" ...10		4	" ... 7		2
" 15	10		" ...15		4	" ...12		4
" 20	11		" ...20		4	" ...17		6
" 25	13		" ...25		3	" ...22		7
" 30	14		" ...30		3	" ...29		10
Feb..... 4	14		*June* .. 4		2	*Oct*.... 4		11
" 9	14		" ... 9		1	" 9		13
" 14	14		" ...14		0	" 14		14
" 19	14		" ...19	1		" 19		15
" 24	13		" ...24	2		" 24		16
March.. 1	13		" ...29	3		" 29		16
" .. 6	11		*July*... 4	4		*Nov*.... 3		16
" ..11	10		" ... 9	5		" ... 8		16
" ..16	9		" ...14	6		" ...13		16
" ..21	7		" ...19	6		" ...18		15
" ..26	6		" ...24	6		" ...23		13
" ..31	4		" ...29	6		" ...28		12
April... 5	3		*Aug*.... 3	6		*Dec*.... 3		10
" ..10	1		" ... 8	5		" ... 8		8
" ..15		0	" ...13	5		" 13		5
" ..20		1	" ...18	4		" ...18		3
" ..25		2	" ...23	2		" 23		1
" ..30		3	" ...28	1		" 28	2	

EXAMPLES.

1. Required the equation of time for Nov. 8th, and how must it be applied.

We find by the Table, that the equation for the 8th, is 16m., and following up the column, we find that it is headed, subtract, therefore, it must be subtracted.

2. Required the equation of time for April 15th, and how must it be applied, *Answer*—00m., therefore, it need n't be applied at all.

3. Required the equation of time for Jan. 12th. *Answer*—9m. to be added.

4. Required the true civil time of the tenth new moon in 1870. for Keokuk, Iowa.

	MEAN NEW MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1870.	1	6	51	0032	2442	25	24	451
~~Luna.~~								
9 Luna.	265	18	36	7276	6454	37	92	767
	267	1	27	7308	8896	63	16	218
I.		1	19					
II.		16	2					
III.			15					
IV.			29					
	267	19	33					
Table IV.... 243								
September.....	24	19	33					
Keokuk diff. Time.		6	6					
Keokuk Time....	24	13	27					
Note, p. 36		12						
Apparent Civil....	25	01	27					
Equation of time...			8					

Keokuk true civil time, September, 25d., 1h., 19m. A. M.

FIRST QUARTER, FULL MOON, AND LAST QUARTER.

As 1 lunation means one revolution, ¼, ½, and ¾ lunation would equal one-fourth, one-half, and three-fourths of a revolution. Therefore, if we add ¼ lunation to new moon, we will have first quarter, and if we add ½ lunation, we will have full moon; and by adding ¾ lunation we get third quarter.

EXAMPLES.

1. Required the moon's first quarter after the first new moon, in 1866, Greenwich time.

	MEAN NEW MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1866.	15	6	53	0416	7303	77	69	277
¼ Luna.	7	9	11	0202	2679	29	25	022
	22	16	04	0618	9982	06	94	299
I.		5	57					
II.		10	17					
III.			7					
IV.			16					
Ans., Jan.	23	8	41					

2. Required the time of the first full moon after the fourth new moon, in 1867; New York time.

	MEAN NEW MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1867.	4	15	42	0118	5509	60	58	299
3 Luna.	88	14	12	2425	2151	46	97	256
½ Luna.	14	18	22	0404	5359	58	50	43
	108	00	16	2947	3419	64	05	598
I.		8	21					
II.		1	36					
III.			15					
IV.			23					
	108	10	51					
N.Y. diff. time,		4	56					
	108	5	55					
Table IV.	90							
Ans., April,	18	5	55					

3. Required the first third quarter after the same new moon, New York time.

	MEAN NEW MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1867.	4	15	42	0118	5909	60	58	299
3 Luna.	88	14	12	2425	2151	46	97	256
*¾ Luna	22	3	33	0606	8038	87	75	65
	115	9	27	3149	6098	93	30	620
I.		8	9					
II.		16	48					
III.			13					
IV.			30					
	116	11	07					
Table IV.	90							
April,	26	11	07					
N.Y. diff. time,		4	56					
Ans., April,	26	6	11					

*¾ Luna. is obtained by adding ¼ and ½ of a lunation together.

THE WEATHER.

THE WEATHER is said to be governed by the time that the moon enters its quarters ; therefore, the Weather is different East and West of us, and the same kind of Weather that we have here extends from the North to the South Pole. If it is true that the Weather is govorneed by the moon, by the table prepared for predicting the Weather, we find that if it is raining in New York the cloud must extend from the North to the South Pole, and that part of the earth's surface to be rained on must be in the shape of a lune, whose width must be 60 degrees. Hence, we consider all predictions of the Weather guess-work, and believe the following rule is the best that can be scared up :

TABLE VII.

FOR FORETELLING THE WEATHER.

If the New Moon, the First Quarter, the Full Moon, or the Last Quarter happens	In Summer.	In Winter.
Between midnight and 2 in the morning...	Fair.....	Hard Frost, unless the wind be South or West
Bet. 2 and 4, morning..	Cold, frequent Showers..	Snow and Stormy.
" 4 and 6, " ..	Rain.....	Rain.
" 6 and 8, " ..	Wind and Rain.....	Stormy.
" 8 and 10, " ..	Changeable.....	Cold Rain, if wind be W., Snow if E.
" 10 and 12, " ..	Frequent Showers.....	Cold, and High Winds..
"Noon and 2, P.M. ..	Very Rainy.....	Snow or Rain.....
" 2 and 4, " ..	Changeable.....	Fair and Mild.
" 4 and 6 " ..	Fair.....	Fair.
" 6 and 8 " ..	Fair, if Wind N.-W. Raining if South or S.-W.....	Fair and Frosty, if Wind N. or N.-E., Rain or Snow, if S. or S.-W.
" 8 and 10 " ..	Ditto.....	Ditto.
" 10 and midnight ..	Fair.....	Fair and Frosty.

In addition to Table VII., we may divide the moon's orbit into twelve equal parts, and find the time of its entrance into each division, by adding one-twelfth lunation at a time. In calculating the moon's phases, if the sun, under column N, is very near 250, the Weather will be a little drier than as indicated by the Table. If very near 750, a little drier.

By following the above instructions, the reader may be able to tell whether the following year will be a good crop-year or not.

Observations.—The nearer the time of the moon's entrance to noon or midnight, the more nearly will the result occur with the prediction. It is also said that the less dependence is to be placed on the Table in Winter than Summer.

1. Required the Weather following the phases previously calculated. It must be remembered that all astronomical time must be reduced to true civil time before predicting. *Answer.*

2. Required the Weather following the new moon in August, 1866, for Missouri. *Answer*—Changeable.

3. Required the Weather following the last quarter in August, 1866, for Missouri. *Answer*—Changeable.

4. Required the Weather following the first quarter, in January, 1866, for Virginia; which will answer for all States due North and South. *Answer*—Fair and mild.

CHRONOLOGICAL.

To Find the Day of the Week Corresponding to any Day of any Month.—Subtract 1 from the given year, add one-fourth of itself, rejecting the remainder; and then add the number of days from the beginning of the year, plus the day of the month. Now divide by 7. (the number of days in the week) and the remainder will show the day of the week.

If the remainder is 0, it will be Sunday.
If the remainder is 1, it will be Monday.
If the remainder is 2, it will be Tuesday.
If the remainder is 3, it will be Wednesday.
If the remainder is 4, it will be Thursday.
If the remainder is 5, it will be Friday.
If the remainder is 6, it will be Saturday.

EXAMPLES.

1. Required the day of the week corresponding to the 4th of July, 1866.

Given Year.....1866
Substract..... 1

Leaves.....1865
Adding one-fourth.. 466

Gives.....2331
July, Table IV..... 181
Add day of the Month 4

Sum.....2516$\frac{1}{7}$=359, and 3 for the remainder.

It has just been stated that, if the remainder is 3, it will be Wednesday. *Answer*—Wednesday.

2. What day of the week will the 7th of August be in the year 1880? *Answer*—Saturday.

3. What day did the year 1700 begin on? *Answer*—Wednesday.

EASTER.

Easter, a festival of the Christian Church, observed in memory of our Saviour's resurrection.

In the primitive ages of the Church, there were very great disputes about the particular time when this festival was to be held. The Asiatic Churches held their Easter upon the very same day the Jews observed their Passover; and others on the first Sunday after the first full moon in the new year.

This controversy was determined in the council of Nice, when it was ordained that Easter should be held upon one and the same day, which should always be a Sunday in all Christian Churches throughout the world.

But though the Christian Churches differed as to the time of celebrating Easter, yet they all agreed in showing particular respect and honor to this festival. It was distinguished by the ancient writers by the name of *dominica gaudii*, that is, Sunday of joy. On this day prisoners and slaves were set free, and the poor liberally provided for. The eve or vigil of this festival was celebrated with more than ordinary parade, which continued till midnight—it being a tradition of the Church that our Saviour rose a little after midnight—but in the East, the vigil lasted till cock-crowing. It was in conformity to the custom of the Jews in celebrating their Passover on the fourteenth day of the first month; but the following rule was finally established by the world:

RULE.

By the Tables, find the first full moon after the 20th of March—the following Sunday will be Easter-day.

The first full moon after the 20th of March is always the third or fourth in the year, and if we know its date, we can tell the date of the next Sunday (Easter-day).

EXAMPLES.

1. Required Easter-day for 1867.

	MEAN N. MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1867.	4	15	42	0118	5909	60	58	299
½ Luna.	14	18	22	0404	5359	58	50	043
3 Luna.	88	14	12	2425	2151	46	97	256
	108	00	16	2947	3419	64	05	598
I.		8	21					
II.		1	36					
III.			15					
IV.			23					
	108	10	51					
Table IV..	90							
April.....	18	10	51					

Civil time, 18d., 10h., 51m.^{pm} Full moon, Thursday, three more days gives Sunday. To April 18th, add three—April 21st —for Easter-day.

2. Required Easter-day for 1868. *Answer*—April 12th.

EASTER SUNDAYS.

1869.....March 28th.	1870.....April 17th.
1871.....	1872.....March 24th.
1873.....April 13th.	1874..... ....April 5th.
1875.....March 28th.	1876.....March 26th.

PERIGEE, APOGEE, &c.

THE words Perigee, Apogee, Perihelion, and Aphelion, are derived from the Greek language, and have the following meaning:

Perigee, near the Planet; *Apogee*, from the Planet; *Perihelion*, near the Sun; *Aphelion*, from the Sun.

It is evident that the moon's apparent size is greatest when the moon is nearest the Earth, or in Perigee, and least when in Apogee. Therefore, if we can find its apparent semi-diameter, at any time, we can also tell when it enters Apogee and Perigee.

TABLE VIII.

SHOWING THE MOON'S SEMI-DIAMETER.

ARG. II.	MOON'S S. D.	ARG. II.	ARG. II.	MOON'S S. D.	ARG. II.
0000	16 29	0000	2750	15 23	7250
0250	16 26	9750	3000	15 16	7000
0500	16 25	9500	3250	15 10	6750
0750	16 21	9250	3500	15 7	6500
1000	16 17	9000	3750	15 3	6250
1250	16 11	8750	4000	14 56	6000
1500	16 3	8500	4250	14 54	5750
1750	15 56	8250	4500	14 50	5500
2000	15 50	8000	4750	14 48	5250
2250	15 42	7750	5000	14 45	5000
2500	15 31	7500			

When calculating the moon's phases, we may also calculate its apparent size. With the sum under column headed II., enter Table VIII., and find its nearest equivalent in column headed II., and the corresponding number in column S. D. will be the moon's semi-diameter. When the moon's S. D. is at the top of the column, it is in Perigee, and when at the bottom, in Apogee. Hence, we may write the following rule:

RULE.

1st. Add to new moon that part of a lunation that will bring column II. to 0000 (or nearly so), which will give the time that the moon enters its Perigee.

2d. Add to new moon that part of a lunation that will bring column II. to 5000 (or nearly so), which will give the time that the moon enters its Apogee.

EXAMPLES.

1. Required the time of the moon's first entrance into its Perigee after the first new moon in January, 1866.

	MEAN N. MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1866.	15	6	53	0416	7303	77	69	277
¼ Luna.	7	9	11	0202	2679	29	25	022
1-512th "	0	1	23	0002	0021	00	00	000
	22	17	27	0620	0003	06	94	299
I.		5	58					
II.		10	10					
III.			7					
IV.			16					

Answer—Jan. 23 9 58—Greenwich Time.

NOTE.—1-512th Lunation is found by dividing 1 Lunation by 512.

2. Required the time it will be in its Apogee after the same new moon.

	MEAN NEW MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1866	15	6	53	0416	7309	77	69	277
1-2 Luna.	14	18	22	0404	5359	58	50	043
7-32 "	6	11	2	0177	2344	25	22	19
	36	12	17	0997	5012	60	41	339
I.		6	50					
II.		10	14					
III.			14					
IV.			26					
	37	6	01					
Table IV.	31							

Ans., Feb. 6 6 01—Greenwich Time.

☞ 7-32 Lunation may be obtained by multiplying 1 Lunation by 7, and then divide by 32.

By inspecting the common almanac, we find that the moon was in Perigee, January 23d, and in Apogee February 6th.

ECLIPSES.

When the light of a heavenly body or the body itself is obscured, it is said to be eclipsed. There are two kinds of Eclipses —first, a heavenly body may be eclipsed by the interposition of another heavenly body; second, an opaque body may be eclipsed by the shadow of another opaque body. Of all the Eclipses, the Eclipses of the Sun and Moon are the most important. An Eclipse of the sun is caused by the moon's getting between it and the earth, and intercepting its rays. This can happen only at new moon, because, when between us and the sun, the moon must present to us her unenlightened side.

The Eclipse of the moon is caused by the earth's getting between it and the sun. This can take place only at full moon, because when the earth is between the sun and the moon the latter must present her enlightened side to the earth.

An Eclipse is called total, when the whole disc is obscured; and partial, when only a portion is obscured. When the whole disc of the sun is obscured, except a narrow ring around the outer edge, it is called an annular Eclipse, from the Latin word *annulus*, a ring.

The greatest number of Eclipses that can happen in a year, is seven; the least number, two; but there are generally four.

If the moon's path coincided with the sun's, there would be an Eclipse of the sun at every new moon, and an Eclipse of the moon at every full moon; but it does not coincide, it inclines to it by an angle of 5 deg. and 8 min., crossing the sun's path at two opposite points.

The moon's orbit is divided into 1,000 equal parts, beginning at that point where the moon crosses the ecliptic in coming North,

which is called its ascending node; and the descending node would be represented by 500. If the moon is at or near either of these points when it is new or full, there is an Eclipse. Column N, when calculating new or full moon, shows the position of the moon in respect to its nodes. If there are more than three figures in the sum of column N, drop the last one in adding.

RULE FIRST—TO FIND THE ECLIPSES OF THE SUN.

Add to the first new moon a sufficient number of lunations to bring column N within 37 *of* 500, 000, *or* 1,000—*the corresponding time of new moon will be the time of Eclipse at greatest obscuration.*

If N is less than 37 or 500, the Eclipse will be visible in the Northern Hemisphere; or, if N is less than 1,000 or greater than 500, the Eclipse will be visible in the Southern Hemisphere.

The amount of Eclipse corresponding to the different points on the earth, belongs to the high mathematics, and must be excluded in a work like this.

If the moon's distance from either node is greater than 37, and less than 53, there may be an Eclipse, but it is doubtful: we shall have to omit all doubtful cases, for their removal would require many minor problems caused by the irregular action of the sun on the moon.

Eclipses are either partial, annular, or total. All Eclipses of the sun that happen within 25 of either node, are either annular or total, and may be predicted in the following manner:

Table IX. shows the semi-diameter of the sun for every tenth day of the year, and by Table VIII. we can find the semi-diameter of the moon. Now if the semi-diameter of the moon is greater than the sun's, the Eclipse will be total, otherwise, it will be annular, as seen from some parts of the earth.

TABLE IX.

SUN'S SEMI-DIAMETER FOR EVERY TENTH DAY OF THE YEAR.

DAYS.	JANUARY.		APRIL.		JULY.		OCTOBER.	
	MIN.	SEC.	MIN.	SEC.	MIN.	SEC.	MIN.	SEC.
1	16	18	16	1	15	46	16	1
11	16	17	15	58	15	46	16	3
21	16	17	15	55	15	46	16	7
	FEBRUARY.		MAY.		AUGUST.		NOVEMBER.	
1	16	15	15	53	15	47	16	9
11	16	13	15	51	15	49	16	12
21	16	11	15	49	15	51	16	14
	MARCH.		JUNE.		SEPTEMBER.		DECEMBER.	
1	16	10	15	48	15	53	16	16
11	16	7	15	46	15	56	16	17
21	16	4	15	46	15	58	16	18

EXAMPLES.

Required an Eclipse of the sun for 1867.

	MEAN NEW MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1867.	4	15	42	0118	5909	60	58	299
2 Luna.	59	1	28	1617	1434	31	98	170
	63	17	10	1735	7343	91	56	469
I.		8	6					
II.		20	0					
III.			14					
IV.			16					
	64	12	46					
Table IV.	59							

Ans., March, 5 21 46—Greenwich Time.

Column N shows that there must be an Eclipse of the sun visible in the Northern Hemisphere.

The result shows Greenwich time, which may be reduced to civil time corresponding to any point in the United States. It must be remembered, that if a Solar Eclipse happens in the night at any place, it will be invisible to that place. As N is tolerably near the limits of a Solar Eclipse, the Eclipse must be visible to the Northern part of the Eastern Hemisphere.

The following is a catalogue of the Solar Eclipses that will be visible in New England and New York, between the years 1865 and 1900; the dates are given in civil time:

1865, October 19th. Digits eclipsed, 8½, on sun's Southern limb.
1866, October 8th. ½ digit eclipsed. South of New York no eclipse.
1869, August 7th. Digits eclipsed, 10, in sun's Southern limb.

This eclipse will be total in North Carolina, Kentucky, Illinois, &c.

1873, May 25th. Sun rises eclipsed at Boston.
1875, September 29th. This eclipse will be annular in Maine, New Hampshire, and Vermont.
1876, March 25th. Eclipse on sun's Northern limb.
1878, July 29th. Two-thirds of the sun's disc will be obscured. Eclipse on sun's Southern limb.
1880, December 31st. Sun rises eclipsed. One-half of the sun's disc will be obscured.
1885, March 16th. 6½ digits eclipsed on sun's Northern limb.
1886, August 28th. Sun's Southern limb eclipsed.
1892, October 20th. Two-thirds of the sun is to be darkened.
1897, July 29th. Eclipse on sun's Southern limb.
1900, May 28th. 11 digits eclipsed on sun's southern limb.

This eclipse will be total in Virginia.

RULE SECOND—TO FIND THE ECLIPSES OF THE MOON.

Add to the first full moon a sufficient number of lunations to bring column N within 25 *of* 500, 000, *or* 1,000—*the corresponding time of full moon will be the time of eclipse at greatest obscuration.*

If N is less than 25 or 500, the eclipse will be on the south edge of the moon. Or, if N is less than 1,000, or greater than 500, the eclipse will be on the moon's northern limb.

If the moon's distance from either node is greater than 25, and less than 35, there may be an eclipse, but it is doubtful. If N is within 10 of either node, the eclipse will be total, otherwise partial.

EXAMPLE.

Required an eclipse of the moon for 1867.

	MEAN N. MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1867.	4	15	42	0118	5909	60	58	299
½ Luna.	14	18	22	0404	5359	58	50	43
2 Luna.	59	1	28	1617	1434	31	98	170
	78	11	32	2139	2702	49	06	512
I.		8	27					
II.		0	20					
III.			10					
IV.			24					
	78	20	53					
Table IV..	59							

Ans., March 19 20 53—Greenwich Time.

We may reduce the above to civil time corresponding to any point; and if the sun is down, the eclipse will be visible at that point.

KEPLER'S LAWS.

1. *The orbits of the planets are ellipses, of which the sun occupies one of the focuses.*

2. *The radius vector in each case describes equal areas in equal times.*

3. *The squares of the times of revolution are to each other as the cubes of the mean distances from the Sun.*

The first of these is a mere fact drawn from observations. The second is also an observed fact—but will admit of an explanation, by Geometry combined with the law of inertia.

The third may be demonstrated by the Calculus—and by geometrical proportion, if we consider the orbits circular, (which is not far from the truth).

Table X. is a tabular view of the *Solar System*, (with the asteroids excluded). By applying KEPLER'S laws, we can find the time of revolution corresponding to any distance.

TABLE X.

TABULAR VIEW OF THE SOLAR SYSTEM.

Names.	Diameters in miles	Distance from the sun in miles.	Time of rev'lut'n round the sun.	Siderial rotation.	Light and heat	Bulk.	Gravity	velocity per min. in miles.
			Days.	D. H.				
Sun. .	883,000			25 12		1,380,000	28.19	
				H. M.				
Merc .	3,224	37,000,000	88	24 5	7	1–15	1.22	1833
Venus	7,689	68,000,000	225	23 21	2	8–9	0.96	1400
Earth.	7,916	95,000,000	365	24	1	1	1.00	1133
Mars .	4,398	144,000,000	687	24 39	½	7–24	0.50	900
Jupt..	89,170	480,000,000	4,333	9 56	1–26	1,300	2.70	500
Saturn	79,040	900,000,000	10,759	10 29	1–100	1,000	1.25	366
Uran .	35,100	1,800,000,000	30,687	9 30	1–330	80	1.06	250
Nept .	39,800	2,850,000,000	60,128	Unknown	1–799	125		
				D. H.				
Moon .	2,160	95,000,000	365	27 7⅔	1	1–49	0.18	38

JUPITER'S SATELLITES.

Sat.	*Dist. from Jupiter.*	*Time of revolution round Jupiter.*		
	Miles.	D.	H.	M.
I	264,490	1	18	28
II	420,815	3	14	58
III	671,234	7	3	42
IV	1,180,582	16	16	32

SATELLITES OF URANUS.

Sat.	*Dist. from Uranus.*	*Time of revolution round Uranus.*		
	Miles.	D.	H.	M.
I	224,155	5	21	25
II	290,821	8	16	57
III	339,052	10	23	4
IV	388,718	13	10	56
V	777,481	38	1	48
VI	1,555,872	107	16	42

SATURN'S SATELLITES.

Sat.	*Dist. from Saturn.*	*Time of revolution round Saturn.*		
	Miles.	D.	H.	M.
I	199,627	0	22	37
II	153,496	1	8	53
III	190,044	1	21	18
IV	243,449	2	17	44
V		4	12	25
VI	788,258	15	22	41
VII	2,297,541	79	7	54
VIII	Not well known.			

NEPTUNE'S SATELLITES.

Sat.	*Dist. from Neptune.*	*Time of revolution round Neptune.*
	Miles.	
I	240,000	

EXAMPLES.

1. Required the time of revolution of a supposed planet whose distance is 200,000,000 miles from the sun.

365^2 days : $(\text{Answer})^2 :: 95^3 : 200^3$.

Answer.

KEPLER'S laws can also be applied to secondary planets.

2. How far is Saturn's Vth moon from the planet.

Answer.

Now let us suppose that the planet Neptune is unknown—we find by observations that it disturbs its neighboring planets in the same point of the heavens every 165 years, therefore, its time of revolution round the sun is 165 years; and by KEPLER'S laws we can find its distance from the centre of motion. The planet Neptune was thus discovered by LE VERRIER and ADAMS.

MISCELLANEOUS.

The following is a list of all the transits of Mercury that will occur between the years 1866 and 1900:

1868	Nov. 4
1878	May 6
1881	Nov. 7
1891	May 9
1894	Nov. 10

Venus will cross the sun's disc in the year 1874, Dec. 8th, and again in the year 1882, Dec. 6th.

The following problems require astronomical resolution: A, in latitude 30 degrees, (immaterial whether North or South) rises with the sun on the 20th of March, and follows his shadow all day—where is he at night, provided he travels three miles per hour? *Answer*—11.7 miles towards the nearest pole.

B, in latitude 00 degrees, rises with the sun on the 22d of September, and follows *his* shadow all day—where is he at night, provided he walks at a certain rate all day?

Answer—At the point where he started.

☞ The two preceding examples may be omitted by all that are not acquainted with Mathematical Astronomy.

To Produce Table I.—Add a sufficient number of lunations to the last horizontal line in Table I., to carry the time column to the first of January of the next year. Every time we do this we increase the Table one year; therefore, we may produce it indefinitely.

EXAMPLE.

Increase Table I. two years.

	MEAN NEW MOON.			I.	II.	III.	IV.	N.
	D.	H.	M.					
1880 L	11	15	0	0284	1370	14	10	015
13 Luna.	383	21	33	0510	9323	93	88	108
	395	12	33	0794	0693	07	98	123
	366							
1881	29	12	33	0794	0693	07	98	123

To the last horizontal line, add 12 Lunations, and from the sum, subtract the number of days in the year 1880, then we have the Table increased one year. In the same manner the reader may keep on increasing it.

VOCABULARY OF ASTRONOMICAL TERMS.

Acceleration—An increase in the rapidity of the motion of a moving body.

Air—A transparent, invisible, elastic fluid, in which we move and breathe.

Altitude—The height of an object.

Amplitude—The angular distance from the East or West, measured on the horizon.

Angle—The opening between two lines that meet.

Angular Distance—The opening of two lines drawn from a given point to two distant objects.

Annular—Having the form of a ring.

Apparent Diameter—The diameter of a body as seen from the earth.

Apparent Motion—The motion of a body as seen from the earth.

Apparent Time—Time as shown by the sun.

Arc—A part of the circumference of a circle.

Argument—A number by which an equation is found.

Asteroids—Starlike bodies which revolve around the sun between Mars and Jupiter.

Attraction—The power of one body to draw another towards it.

Calendar—An almanac.

Cardinal Points—The North, South, East and West points of the horizon.

Centrifugal Force—The tendency that a moving body has to fly off into a straight line.

Centripetal Force—The force which draws a moving body towards the centre of motion.

Degree—One-360th part of the circumference of a circle.

Digit—One-12th part of the apparent diameter of the sun or moon.

Disc—The apparent surface of a heavenly body.

Earth—The sphere on which we live.

Ecliptic—The plane of the earth's orbit.

Equator—A great circle of the earth, 90 degrees from the poles.

Equinoxes—The points where the sun crosses the Equator.

Horizon—The circle where the sky and earth appear to meet.

Limb—The edge of the sun or moon.

Minute—One-60th part of a degree; also, one-60th part of an hour.

Nadir—The point directly under foot.

Opaque—Not luminous.

Radius Vector—A straight line drawn from the revolving body to the centre of motion.

Rotation—The motion of a body round its axis.

Satellite–A moon, or secondary planet.

Second—One-60th part of a minute.

Transit—The passage of a body across the sun's disc.

Zenith—The point in the heavens directly overhead.

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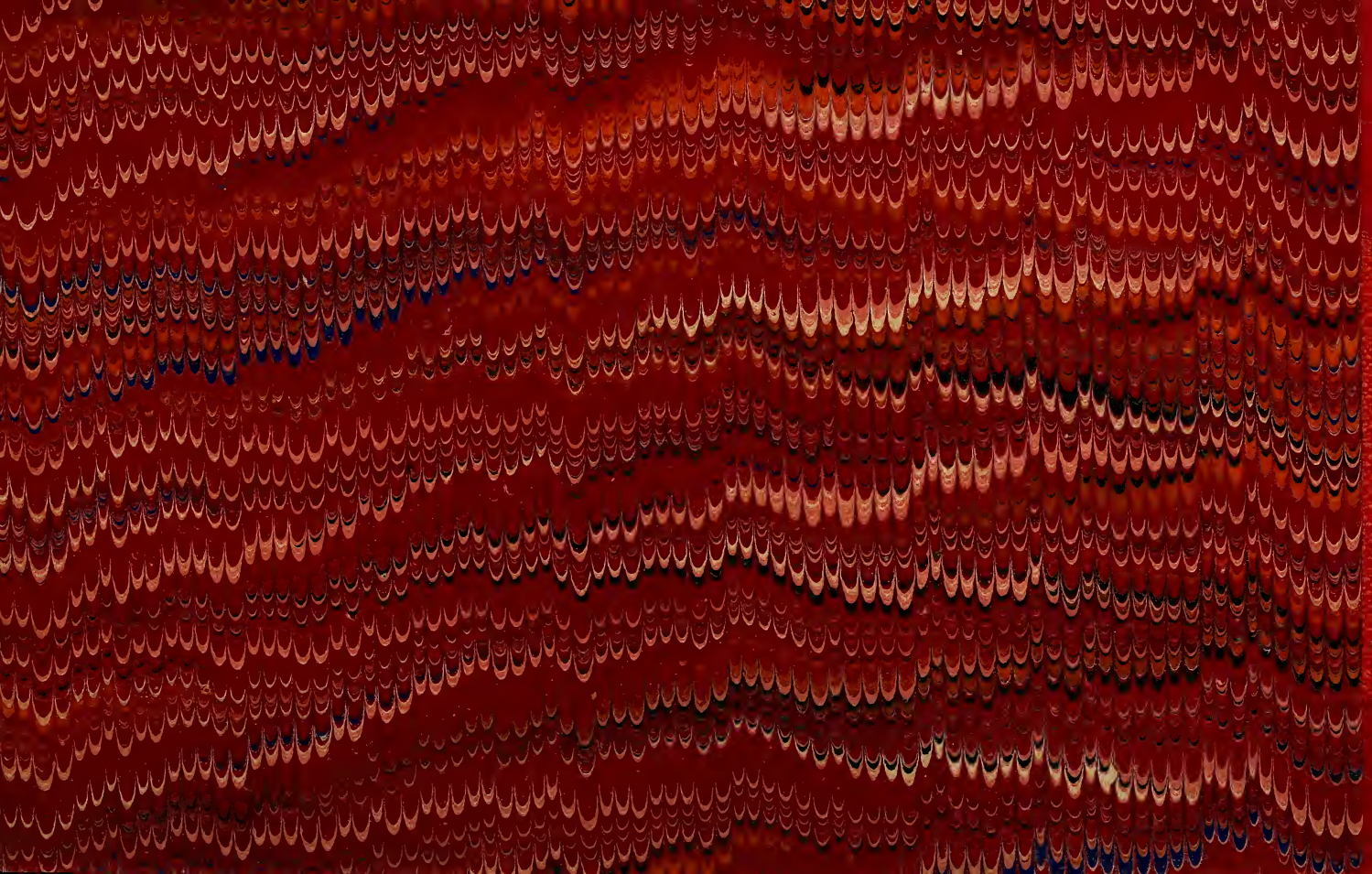

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